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Research-able through Problem-Based Learning

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Abstract: This research project describes an attempt to move towards a more student centered and participatory approach on learning through problem-based storyboards (themes/scenarios) and a unique opportunity for students to have an academic cross-cultural exchange. The purpose of the study was to analyze students´ conceptions of this approach on learning through storyboards, experiential learning and the evolution of assessment methods that reflect and further student capabilities. While student satisfaction with the aims of the course was high and technology facilitated a unique cross-cultural opportunity, the challenges of maintaining reliable technology and matching student expectations proved challenging. Despite critical comments, the overwhelming outcome was positive.

Keywords: problem-based learning, student-centered, storyboard, ICT, research-able

I. Introduction.

This paper is a case study to improve the learning experiences of university students through the use of innovative collaboration technologies and novel methodology to make students more motivated and research-able[2] through problem-based learning.
The Remote University Network (RUN) for human performance is a joint research and development project in technology and education between the University of Gothenburg (GU) in Sweden and Stanford University (SU) in the USA financed by the Wallenberg Global Learning Network (www.wgln.org). Within the RUN project, students from GU and SU have the opportunity to take part in a joint Human Biology course. The course unit at GU, entitled *"Biomechanics and Human Performance, (7,5 ECTS)",* involves collaboration between various disciplines such as medicine (anatomy, physiology), exercise science and pedagogy. At SU, the course is titled *"Functional Human Anatomy"* in the department of Human Biology. This course is unique in that it uses a blended learning[3] approach, which focuses on processes and problem-based perspectives. Instead of traditional didactic learning with lectures and examinations, students themselves search for the information they require and create a team-based research project. The advantage of running a joint international course is that the quality of the content is raised because of possibilities of using international experts and that students get a unique cross-cultural exchange. The aim of the course was defined in the syllabus as follows:

> The course unit is intended to provide students with increased knowledge about how human movement is controlled and adapted with focus on sport, health and performance. This will be achieved by the integration of a number of basic biomechanical, anatomical and physiological principles. An additional aim is to develop the students' ability to work independently and in a group, to search for new knowledge as well as to employ interactive teaching aids and communications systems.

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[2] Research-Able is the concept we use for making students become more reflective and critical as well as knowing more about scientific methods (Kjellgren *et al*., 2008).
[3] "Blended Learning is learning that is facilitated by the effective combination of different modes of delivery, models of teaching and styles of learning, and founded on transparent communication amongst all parties involved with a course" (Heinze and Procter, 2004).

The general aim for the project was to develop and create a network of contacts in the area of exercise science research and higher education through developing a joint international course, where new pedagogical modes of working and learning were being focused and where student learning and motivation were central. Before describing the research project in detail we comment more broadly on our conceptions of teaching and learning in university settings.

II. Perceptions on teaching and learning.

Bruner (1996, p. 129) claims that education has to include a critical component so that students are equipped to ''go beyond … information … to figure things out" for themselves. However, this noble aim is not always achieved and teaching methods often remain the same. Ruth (1997, p. 1) claims that, "while a medical doctor from the previous century would not recognize the technology in today's hospital, a college professor from that era, would see virtually no change in the tools of education". Even though we do not fully agree with the rather stark conclusion of Ruth, we do agree that teaching methods need to be examined and developed and that there definitely are lots of alternatives to stereotype lecturing in academic institutions.

During the 1980s most research projects designed to improve learning in higher education focused on teaching and the ways in which learning activities were structured, organized and presented by the teacher (Dunkin and Barnes, 1986). In the early 1990s this orientation had broadened to include the relationship between teaching and learning, with particular emphasis placed on the latter (Ramsden, 1992). As the 1990s progressed, student learning was being focused and effective teaching and learning became a central theme and organizing principle of academic education. Towards the end of the 1990s, quality questions were raised and the way students learn was problematized and related to the way teaching was conducted. The necessity of taking the learner's perspective and trying to change the teaching towards a more learning centered approach was discussed (Marton and Booth, 1997).

All theories of learning are based on assumptions concerning the individual, the world and the relationship between the two. Our notion of learning is that, as much as possible, it needs to be grounded in daily activities and cannot be separated from the complex environments in which knowledge is applied. Learning is mostly the result of social processes that require problem solving and negotiation with others and results from engaging in difficult issues and dilemmas.

By situated learning within social and cultural contexts the individual is continuously involved in constructing knowledge through direct experience of social practice (Säljö, 2005). This can be regarded as an active process where students are seeking information related to the task and the given context, and testing this within the context formed by the task and the environment. Situated views on learning originated with, among others, the work of Lave (1988), Brown *et al*. (1989), Rogoff (1990) and Lave and Wenger (1991).

Lave (1988) focuses "on relations between socio-cultural structure and social practice" (1988, p. 177) and her focus is on the inseparability of the individual, activity, and environment. The assumption is that development and learning emerge from the relations among rather than interactions between individual, activity, and environmental factors (Rogoff, 1990). Brown *et al.* (1989) were critical towards education that teaches content in decontextualized ways and stated that "by ignoring the situated nature of cognition, education defeats its own goal of providing useable, robust knowledge" (p. 32). They argue that

teaching and learning needs to reflect how the subject matter is used outside academic settings. Thus, situated learning theories offers perspectives on learning that are well supported by research and have been successfully applied in education.

Within research on learning there are also various perspectives discussing students´ engagement and approaches to learning in academic settings (Ramsden, 2003). Approaches to learning are primarily concepts that characterize students as either active or passive in their learning and having either a deep or a surface approach towards learning (Marton *et al*., 2006). Students seem to do what they think is asked of them, using techniques to learn as much factual knowledge as possible, or they are interested in the subject in a way where understanding and comprehending course material is the focus (Biggs, Kember and Leung, 2001). On the other hand, students´ view on education is not once and for all fixed, but instead constructed in relation to the learning context.

In developing our new course we wanted the students to reflect on their own learning and to be aware of possible applications of the knowledge they acquired. Therefore we decided to include reflective blogs as concrete ways of structuring reflections both individually and in groups. Schön's (1983, 1987, 1991, 1995) literature on reflection has made a significant contribution to the discourse on learning and education, and his concepts of reflection-on-action and reflection-in-action are widely used in educational settings. A repeated spiral of appreciation (problem setting), action (strategy generation, experimentation, evaluation) and reappreciation (problem setting) is, according to Schön (1995), referred to as a reflective conversation. This reflective conversation is what problem based learning, especially when working in groups, is trying to accomplish.

A. Problem-based learning.

Problem-based learning (PBL) is a pedagogical approach that has been used successfully over the years and continues to gain acceptance in multiple disciplines. For example, Socrates presented students with problems that through questioning enabled him to help them explore their assumptions, values and understanding. In more modern times PBL, as a general model, was developed in medical education in the early 1970s and since that time it has been refined and implemented in many different educational contexts (Barrows and Tamblyn, 1980; Barrows, 1986; Savery and Duffy, 1995; Duch, Gron, and Allen, 2001b).

PBL is a learner-centered approach that empowers learners to conduct research, integrate theory and practice, and apply knowledge and skills to develop a viable solution to a defined problem (Savery, 2006). Duch, Groh, and Allen (2001a) have summarized the methods used in PBL and the specific skills developed, and these include the ability to think critically, analyze and solve complex, real-world problems, to find, evaluate, and use appropriate learning resources; to work cooperatively, to demonstrate effective communication skills, and to use content knowledge and intellectual skills to become self-directed learners.

Our understanding of problem-based learning is through constructivist learning theories. From a socio-cultural perspective the learner is seen as transforming as well as being transformed when participating in communities of practice and the PBL group might be regarded as such a community. Thus, the focus is on learners as constructors of their own knowledge in a context, which is similar to the context in which they would apply that knowledge. Students are encouraged and expected to think both critically and creatively and to monitor their own understanding. Social negotiation of meaning is an important part of the problem-solving group structure. However, the faculty is responsible for sensitizing students

to learn what learning might be and creating environments conducive to learning and thereby helping them to become 'reflective practitioners', to borrow Donald Schön's (1987) phrase.

Thus, the role of the tutor during PBL is that of a facilitator of learning. Therefore, tutors need to have subject matter knowledge but also subject-specific pedagogical knowledge as well as general pedagogical knowledge (De Grave *et al.,* 1999). In his discussion of the tutorial process Barrows (1992) states:

> *The ability of the tutor to use facilitory teaching skills during the small group learning process is the major determinant of the quality and the success of any educational method aimed at 1) developing students' thinking or reasoning skills (problem solving, metacognition, critical thinking) as they learn, and 2) helping them to become independent, self-directed learners (learning to learn, learning management). Tutoring is a teaching skill central to problem-based, self-directed learning.* (p. 12)

A meta-analysis of 20 years of PBL evaluation studies was conducted by Albanese and Mitchell (1993), and also by Vernon and Blake (1993), and their conclusion was that a problem-based approach was equal to traditional approaches in terms of conventional tests of knowledge. Apart from that, students who were using PBL also showed very good problem-solving skills. Students in problem-based learning programs also seem to place more emphasis on meaning (understanding) than reproduction (rote learning and memory) (Entwistle and Ramsden, 1983; Savin-Badin, 2000). Marton and Säljö (1976) talk about two approaches to learning – a deep and a surface approach, where students according to a deep approach emphasize understanding and meaning and this is what is emphasized in PBL.

In summary, there is growing evidence that real-world type of questions and learning activities that are student-centered may be more valuable than traditional teacher-centered lectures (Martin *et al*., 1998; Norman and Smidt, 1992).

These conceptions on teaching and learning were our point of departure as far as pedagogy is concerned and it meant implications for how we wanted to design our course and what methodology to use when designing the course structure and the way it was distributed.

III. Design and organization of the course.

A five-week joint course, here called RUN (Remote University Network), took place concurrently at Stanford University (SU) and University of Gothenburg (GU) during spring 2007 (http://runproject.stanford.edu). This course was co-developed by the faculties at SU and GU. During the course, students at both universities had access to globally-distributed expert key note lectures and various online resources and learning methods to study biomechanics and human performance. The main concept and the design of the course, initially given by Rydmark, are presented below and in Figures 1 and 3. Experiences gained from the LearnAble-project at the Sahlgrenska Academy (GU) were fundamental for the course (Hultberg *et al*. 2008 and Kjellgren *et al*. 2008). The introduction and examinations portions were conducted separately – each institution used its own guidelines to assess their students´ learning.

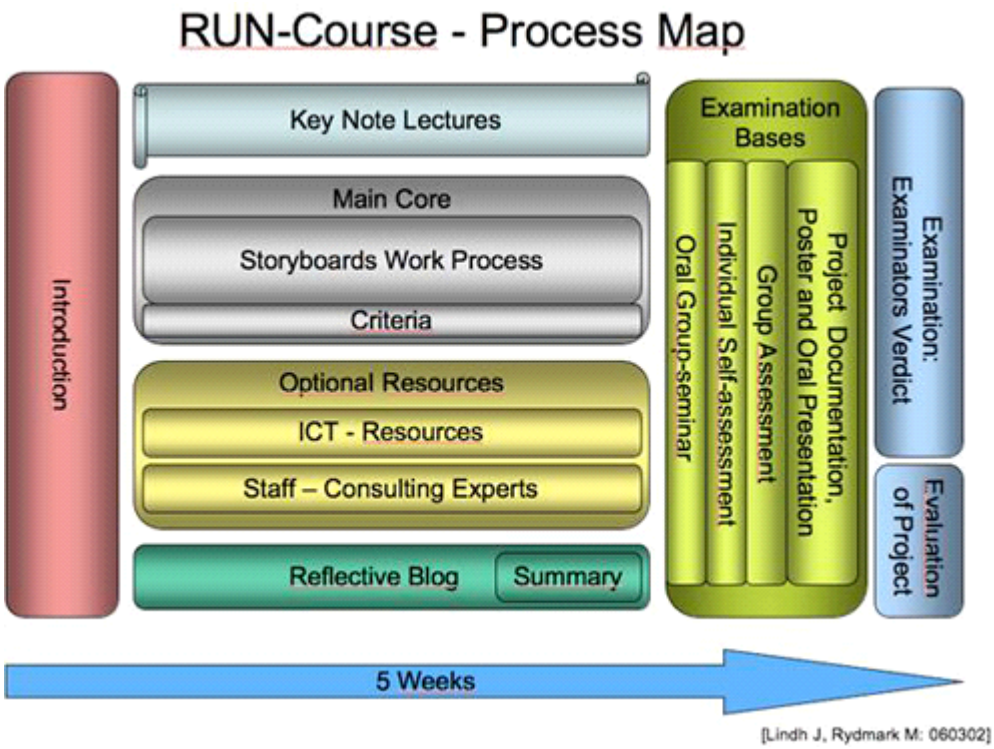

Figure 1. Design of the RUN-course. Key terms are explained in the following subsections.

Introduction.

The goal of the first week was to set up groups, orient the students to the course design, technology, participating faculty, and to their group members. A pilot study the previous year indicated that this type of arrangement helped students work more effectively. Students from each institution formed groups of 3-4 based on their preference for one of 4 (SU) to 6 (GU) project "storyboards" (see below for details). Each group partnered either with another group from the same institution or from the other institution (Figure 2). Each group was also assigned to a teaching mentor for the duration of the project. In total, there were 40 students at SU and 68 students at GU with 63.1% female and 36.9% male students.

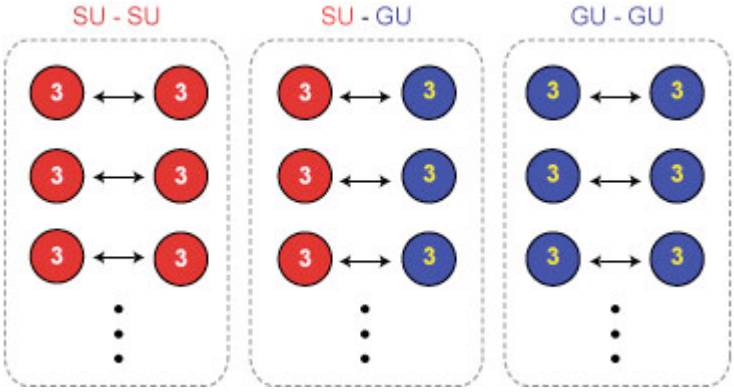

Figure 2. Diads of groups: SU-SU, SU-GU, GU-GU.

Students spent the introductory week to get to know each other and to become familiar with the online components of the course: Marratech[4] and PingPong[5] programs. Marratech and

[4] Marratech is an audio/video multi user communication and conference system (www.marratech.com).

PingPong were used to allow students to participate in Key Note lectures from another institution and communicate with each other asynchronously and synchronously using shared whiteboards, blogs, wikis, chat, and course management software. After the introductory week, the students started to work independently on their own storyboards.

Storyboards.

Storyboards[6] are defined by Cave (2002) as "a popular management tool to facilitate the creative-thinking process and can be likened to taking your thoughts and the thoughts of others and spreading them out on a wall as you work on a project or solve a problem". These creative outlines of ideas for project work were designed to allow student groups to work on a particular application of biomechanics and human performance (mostly exercise science) that required integration of educational goals. Each storyboard was a learning tool that required innovation, cooperative work, research design and execution in a human performance lab. The storyboards were purposely kept somewhat vague, with respect to focus and methodology, to allow degrees of freedom for students´ planning. Over the five weeks of the course, students had to manage all available resources to help produce a scholarly work that could lead to further research. Students could choose from 4-6 different storyboards: ankle, shoulder, knee, back, running economy (GU only), cross-country skiing (GU only).

Keynote lectures.

Experts in the field, originating from Gothenburg and Stanford, presented specially designed lectures 15-30 minutes long that discussed content that could not be typically found in conventional textbooks. Students watched the lectures live using Marratech or reviewed the recordings as streaming media accessed through links in PingPong.

Resources for Information and Communication Technologies.

Through our universities we had access to computers, microphones, web cameras and big screen televisions for meetings and laboratory work. Technical support from our departments was also available every time we were on line for meetings and labs.

Faculty Consultants.

Faculty was recruited to serve as consultants to the student groups. Besides answering to e-mail, they were available face-to-face or online at Marratech on scheduled times or after previous agreement via e-mail. This optional resource was provided to give edge quality in consultation.

Reflective Blog.

Students had to keep a reflective blog in PingPong that recorded their experiences throughout the course. The blog was utilized by students as an element of reflective learning, a strategy that was used to stimulate students to use their own experiences to discover learning for

[5] PingPong is a LMS (learning management system).
[6] Klaus (2002) defines a storyboard as "a plan for teaching and learning activities. It can be a combination of outlines and visual sketches (e.g., flowcharts) that map out the contents or sequence of ideas".

themselves. At the end of the course the students were requested to review their blogs and summarize their own key findings.

Assessment at GU.

Here assessment is primarily seen from the perspective of the GU student learning, with only some insight into the procedure at SU.

Stage at spring 2007: Student assessment involved an element of structured reflection; self-assessment. Students were asked to grade themselves based on how well they had met objective criteria that were presented in the course introduction as well as how effective the students perceived their learning. These individual assessments were then presented to the group for further discussion and evaluation. The student's final grade rested with the course director's objective assessment, including an evaluation of the formal presentation of the group research and a small written examination.

The self-assessment pilot trial was held for the Gothenburg students (n=32) during the final day of the RUN course of 2007. The purpose was to test if the self-assessment model was useful for students to enhance learning in biomechanics during a course like RUN. The students were informed about the purpose of this pilot trial before the assessment.

The self-assessment consisted of two parts, one individual self-assessment (ISA) part and one oral group seminar part. During the ISA the students had to answer three key questions in biomechanics, just like in a traditional written examination. Immediately after the students had answered all questions, they received the correct answers from their teacher. They now had to sit in the lecture hall and reflect upon their own answers and the correct answers written by an expert, and assess if they "Passed" or "Did not pass" this test (84% passed). There was no limit for "Passed" suggested by the examiner. The students had to assess themselves and decide on their own if they "Passed" the key questions in biomechanics or not. The students that answered "Did not pass", had to fill in what they needed to learn more about in order to pass the test. Then, all students received a one hour study-break to enable them to reflect upon their answers before being assessed by their tutor in a group seminar. The purpose of the group seminar was for the students to make sure that they understood all key learning points and for the tutors to learn more about their students learning progress during a course like this. The outcome of this pilot assessment was very positive. All tutors and 91% of all participating students answered that this concept was very useful for learning key concepts in biomechanics and should be implemented during the next RUN course.

Stage at spring 2008: For the spring 2008 course, an internet-based software for self assessment as a base for examination was developed and used as a result of the pilot course in 2007. The intention was that this would give good feedback both to the student and the faculty. The individual student was i) presented to a set of questions and asked to ii) give written answers which were "locked" at submission. Then, iii) suggested correct answers were presented and iv) the student was asked to reflect over i-iii. Finally, v) the student had to give a statement, either "passed" or "not passed". In the former case the whole self assessment was sent to the examiner, in the latter case the student was also requested to suggest a work plan in support of fulfilling her/his educational goals, and was thereby given a new chance to fulfill the educational goals at a later specified date. In a summarizing group seminar with the students the examiner discussed the validity of the self-assessments and commented upon the outcome and, if necessary, gave additional questions to the students.

The advantage of an interactive ISA is that the students can assess and reflect upon their own learning in key points only by clicking on a link and with almost no administrative

work for tutors. Tutors can collect their student's answers by logging into a page and use the results for the group seminars. A similar concept has been tested previously on dental students in Lund and Malmö in Sweden (Mattheos *et al*, 2004, Leisnert and Matheos, 2006).

Assessment at SU.

Students at SU were assessed based on a content mid-term examination, a content final examination, and a project presentation in the format of a Power Point presentation or poster. Students evaluated themselves during each week of the RUN course and the final project was evaluated by their teacher mentor and faculty experts at SU. Due to space constraints we are unable to present this in more details here, but will do so in a later paper.

Presentation of Storyboard work.

Each GU student project group submitted a scientific report at the end of the course. The scientific reports were allowed to be 5-8 pages long, with the main focus on new scientific knowledge extracted from the laboratory experiment versus results from other similar scientific experiments. A keynote lecture on the project design was presented to the students covering a scientific approach, design, and presentation technology and performance expectations. Students were also given the option to have experts´ comments on their achievements before finalizing their work. All findings from the scientific report were presented orally as a Power Point presentation in front of the class. Fellow students and an expert panel commented on their work. The scientific reports and the Power Point presentations were graded after the course by tutors, with the verdict "Passed with distinction", "Passed" or "Not passed". The grading was based on scientific approach, content, oral presentation and individual efforts.

Posters.

GU students presented their significant findings by producing power point-based posters and by following common protocol for posters at international conferences. A keynote lecture was presented to the students with examples and guidelines for the posters. All project groups were asked to show their poster on a big screen after their oral presentation in class of their storyboard work. Their fellow students and an expert panel could now reflect critically upon their work. The posters were graded by tutors with "Passed" or "Not passed". The grading was based on content, design, oral presentation and individual efforts.

Examination.

At the end of the course the students presented their work in the form of a poster and by means of a mini-lecture on the subject of their own poster. Examination took the form of the students making a self-evaluation of their work both independently and within the group, which was then judged and graded by the examiner (see above). The faculty responsible for examination will in all cases summarize the above components of assessments, examinations and presentation for the final verdict.

Pedagogy.

One of the most important conclusions reached by faculty during the pilot study was that this integration of mathematics, physical sciences, and biological sciences, required a new pedagogical approach to teaching. The GU faculty developed a pedagogical model (see figure 3) that not only called upon students to meet educational goals within the curriculum, but also to develop skills required of independent researchers. This pyramid approach emphasizes the progression of students from learners to researchers as they complete the course. The course therefore required the students to actively *learn* key concepts in biomechanics and exercise science through lectures and independent work. Then, students had to begin *constructing* solutions and models to test their solutions. Finally, the group derived data to be able to evaluate their proposed solutions, a key component of *research*. The aim was to provide students with the skills to be able to produce research (Jenkins and Healey, 2009).

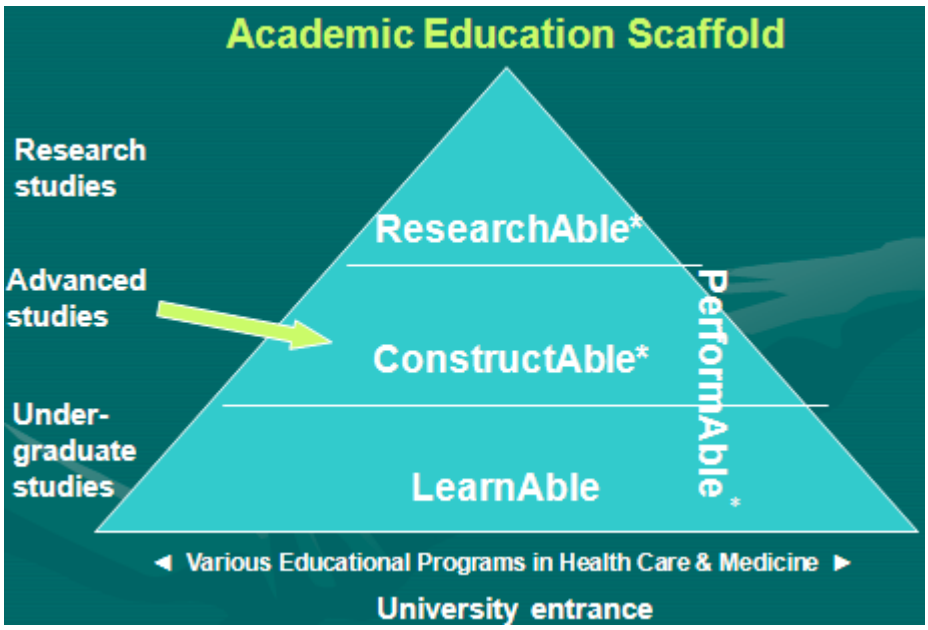

Figure 3. Advancement of the LearnAble model. *Project phase.

The course was led by staff from the School of Sport Science and the Sahlgrenska Academy at GU and from the department of Human Biology at SU. GU staff included a course director, two teaching mentors, and 2 student evaluators; SU staff included a course director, four teaching mentors, a technical support team, and one project manager.

IV. Purpose of the empirical study.

This study analyzed students´ conceptions of the content and pedagogical approach of the course by studying how new technology changes the process of learning from both the student and faculty perspective and how the cross-cultural exchange between students changes the educational quality.

V. Method.

The study was carried out by engaging two graduate students (Bohlin and Kocken, 2007) who followed the course and collected data during the five weeks, while being closely tutored by a faculty member (Annerstedt).

The study used an ethnographic research design to gather evidence on the students´ questions, actions and meaning-making in their natural settings while playing an active part in the production and interpretation of data (Tedlock, 2000).

Hammersley and Atkinson (1995) have described ethnography in the following way: "In its most characteristic form it involves the ethnographer participating, overtly or covertly, in peoples daily lives for an extended period of time, watching what happens, listening to what I said, asking questions – in fact, collecting whatever data are available to throw light on the issues that are the focus of the research." (p. 1). Further, we agree to Kullberg´s (2004) analysis that ethnographic researchers attempt to capture "the perspective of the subjects and tries to see the world through their eyes (p. 43).

Sparkes (1992) states that, in order to truly understand the world through the eyes of the informants, it is usual for ethnographic researchers to actively try to become part of the group under study. This is what Bohlin and Kocken tried to accomplish as researchers in the project.

According to Stukat (2005), ethnographic studies usually involve a qualitative research method for collection of data employing informal and formal interviews (conversations and in-depth interviews) as well as participant observation. Kullberg (2004) likewise mentions that several data collection methods can be employed in an ethnographic study, which she describes as "method triangulation" and which can be used to establish the validity and trustworthiness of the results.

Participant observations were used throughout the evaluation process, although both formal and informal in-depth interviews at individual and group level during the course were also employed. On completion of the course unit, the students answered a questionnaire in order to further strengthen the analysis. The purpose was to establish whether the data obtained through observations and interviews agreed with the students' perceptions.

Bohlin and Kocken (2007) observed and talked to all students and the course leaders during the first weeks of the course, after which they concentrated on three groups of students and their perceptions. Two of these groups consisted of both Swedish and American students, while the third comprised Swedish students only. In order to gain an insight into and as true a picture as possible of how the students and the faculty perceived the course and its outcome, they were observed and conversations (informal interviews) held with them on a continuous basis. During the course, the two ethnographic researchers spent four weeks in Gothenburg and one week at Stanford in order to obtain a fuller picture of the outcomes in the Swedish part of the course in relation to the American outcomes.

VI. Results.

In this section we present data from the 2007 RUN-course and we mainly present data from the GU students in this article and include some comparisons with SU students. Data from interviews, questionnaires and participating observations are compared according to the method of triangulation in ethnographic research discussed by Kullberg (2004). The students who participated in the course in Gothenburg numbered 68, of whom 59 (87%) answered the questionnaire. The focus interviews with three student groups included altogether 13 students and interviews were also carried out with three members of the faculty. Participating observations as well as informal discussions were used continuously during the five-week period.

At SU the students numbered 40 and data were collected through questionnaires, interviews (with three focus groups) and participating observations. Two interviews were carried out with faculty. The teaching evaluation from the faculty was also compared

between the RUN course in 2007 and the more traditional didactic presentation of the course in 2006.

A. Pedagogical approach and learning outcomes.

Students provided constructive feedback on the pedagogical design of the course and suggested ways to improve the course logistics. The majority of both the GU and the SU students (78%) stated that they liked the design of the course and were enthusiastic about the student-centered approach. This included problem-based learning and the possibilities to interact and get to know students from another country studying in the same content area.

Problem-based learning.

The data showed that the students differed in their opinion about the method of working, but agreed on the whole that it had been satisfactory or very satisfactory, as they believed that they would better remember what they had learnt. They were especially satisfied with the opportunity to influence the content of the course including being able to choose how to design their storyboard and research project. This process increased the student motivation where they could either themselves, or together with their supervisor, decide what to enter more deeply into in order to solve their assigned problem. The questionnaire study revealed that 74% of the GU students considered PBL to be a positive method, which they preferred to the more traditional lectures and examinations. All of the students in the GU focus groups expressed their agreement that PBL enabled them to explore and learn on their own and at their own pace. One male GU-student commented:

> *I like to find information for myself because I learn more this way… and sharing this with the others in the group is stimulating.*

One of the faculty members at SU also specifically pointed at problem-based learning as a positive challenge that made him more motivated and creative in his teaching:

> *I have found that traditional teaching is less stimulating as an educator. The majority of my time is spent finding ways to keep students entertained during lectures. In addition, it seems as though students simply wait until the days before an exam and simply memorize facts so that they can pass. Learning is not as much a priority as getting a good grade. With problem-based learning I am constantly challenging myself to respond to the questions posed by creative minds – it is infinitely more challenging as an educator.*

However, students expressed frustration with the open design of the course where they needed to search for solutions – they would have preferred more guidance and more direction from their instructors. As one GU student declared:

> *I think it would have been a good idea if we had… sort of a basic course in the beginning. It could have been problem-based learning all from the start, but the teachers should actually have been here… and that we could have gotten a little more ordinary teaching as we are used to.*

At the start of the course, the students also appeared to worry about how they would find information relevant for their storyboard and expressed that they would have liked more guided instructions. However, upon completion of the course, the questionnaire responses

showed that as many as 78% of GU students had had no problem finding such information. One student stated:

> *Because we didn't get very much guidance and help in the beginning…when we were about to start with our storyboard, we just had to gather as much information and facts as possible on our own. And we have learned a lot from that, but it has for sure meant just as much work as working with a ten-week essay… even though, during this course, it was just equivalent to three weeks!*

Bohlin and Kocken (2007) also noted that the differences between GU and SU evaluation methods and approaches lead to a less collaborative approach to assessing their own students. As a result, students, especially at GU, perceived the initial weeks of the course as "disorganized" and did not see how the course approach contributed to their learning. However, as the course progressed, there was an improvement in the organization that was noted by the students.

The course design fostered skills that students may not get from a traditional didactic classroom. The majority of both groups (81%) felt that the course contributed to these life skills – that the strength of a team results from the diversity of the team members and how to manage decisions, workload, and collaborations within a team. More specifically, students reported that they learned about "cultural differences", "how to communicate effectively and efficiently", gaining insight into how to approach problems", and getting a "global perspective on the same topic". They also understood the challenges that teams normally face, with managing expectations and work distribution being the most common comment, and learning how to best utilize each team member's skills effectively.

The social context of learning from each other when working in groups worked well. Writing about their own storyboard, together with presenting it, gave their work a real touch and made the students more aware of the research process. However, according to the questionnaire, 65% of the GU students perceived their assigned storyboard as difficult to work with. On the other hand, the evaluations made on completion of the course indicated that the students were satisfied or very satisfied with this student-centered and more independent method of working.

The students were positive towards working in groups. Students in the groups engaged actively in the learning process and formed a type of learning community, with each making a meaningful contribution, as they tackled the problems. The responses to the questionnaire revealed that 63% of the GU students agreed completely and 30% partly with the statement that collaboration within the group had been satisfactory.

Teamwork is more commonly practice for GU students, but less so for SU students, so GU students' perception about teamwork changed little as a result of the course. However, the majority of the students from both institutions commented on the value of the teamwork and skills they gained as a result of this course. After the RUN course, more students reported that they were more comfortable working in a group. Here are some comments on the group work stated by SU students:

> *This was the best group work I have done at Stanford…my group was very respectful, focused, and each brought different strengths to the group.*

> *Even though I have had a lot of group work experience, I did feel that this class was more of collaboration between us, the TA's (mentors), and the professors than I've experienced in the past – which I found very helpful.*

> *I discovered that you can go deeper into a subject and also divide different areas of the subject between the members. Each member can do research within their area and then you*

> *put it together and discuss it. Everyone within a group is good at different things. This is good, and in the end I believe that the work will have a better quality and be better thought throughout if it has been accomplished by more than one. More critical eyes.*
>
> *It brings together more energy and vibrancy to a project, more points of view, more strengths of varied backgrounds and diverse information sources, making the atmosphere creative and stimulating. It is also important to have others to bounce off and critique the validity of my ideas.*
>
> *Working in a group setting is beneficial in that you have the opportunity to bounce ideas off one another and get perspectives on themes that you could not have come up with on your own.*

The students' responses to the questionnaire showed that 51% considered that the relationship with their pedagogical mentor had been satisfactory or highly satisfactory. However, an equal number reported that they did not receive adequate assistance during the course, although observations and informal interviews revealed that the supervisors had been highly committed and tried to help the students as much as possible (Bohlin and Kocken, 2007).

Reflective blogs.

The activity of writing reflective blogs was appreciated by most students. However, to write with an analytical perspective was perceived as very demanding and not intuitive to students. Many students asked for guidance at the beginning of the course - they wanted detailed and specified instructions about how to write a reflective blog. Students seemed to eventually learn how to write a reflective blog as the course progressed. Our general impression was that the students were more interested in learning the subjects included in the course, than to think about how they learn and to reflect about their process of learning. Yet, a lot of students reflected around the learning process and commented on it in their blogs. A Swedish female student wrote:

> *I really hope I have helped to make my fellow class mates think that I have put forward some ideas that have helped us to make progress in our group work.*

Comments such as how the students reflect on their own learning were also an important goal in the course.

Content.

The students appeared to perceive the course content as relevant and that they had gained much knowledge during the course. The questionnaire revealed that 52% were of the opinion that they had learnt a great deal, while the majority of the students interviewed (informal and formal) reported that they had learnt most within their specific area, i.e. in connection to their own storyboard and not as much about the content in the other storyboards presented.

However, Bohlin and Kocken's (2007) observations and formal interviews also showed that many GU students regarded their basic knowledge of biomechanics too poor for working with PBL. Some suggested that more focus should be placed on biomechanics at the start of the course in order to make the students more prepared and able to apply the knowledge in sport activities. Looking at students´ answers, it seems as if basic knowledge in the given content area is a prerequisite for PBL.

In summary, the ethnographic data emphasize that the researchable coursework played a predominant role in students' work and learning in the RUN course. Keynote lectures and the course literature were still necessary (and requested by the students); they established the foundation of knowledge necessary for group investigations, overall students reported substantial increases in comfort and competence directing their own learning through guided research questions and explorations. These student-reported survey and interview conclusions were corroborated by the quality of the proposals, lab work and final poster presentations that made up the graded portion of students' collaborative grades. Students responded very well to the challenge of open-ended group storyboard research questions, and were eager to engage faculty and course tutors for guidance as they narrowed research questions, conducted laboratory tests, and analyzed results.

B. Communication and ICT.

An essential element of constructable and researchable course goals involved cross-cultural interactions and collaborations through the use of ICT. These interactions predominantly focused on the use of Marratech software during collaborative problem sets and interactive discussions of student-directed research. While video conferencing, interactive white-board use, and document sharing were presented as avenues through which students could engage each other as colleagues investigating similar storyboard-based research questions, subjective staff evaluations as well as student survey responses illustrate that this aspect of the course was not received as positively as was hoped.

Using ICT throughout the course and being dependable on this was different from most other university courses the students had taken. Marratech, PingPong and lectures on wide-screen TVs broadcasted from other countries was regarded as quite new and exciting by the students. One SU student commented:

> *Just the fact that we can take part in a course like this is almost unbelievable. Like…, just think about the lecture we had the other day, you know. There wasn't anybody lecturing. We sat down and looked at a video-screen and listened to somebody who gave a lecture for us and another class. This is something I have taken for granted just because we have a globalized world, but it is quite astonishing! To be in a lecture from the other side of the world with somebody who is a real expert in the field… I don't know, but I think it is pretty cool!*

The biggest challenge reported by the students was the technical aspect and time differences. One focus group stated:

> *If the Americans in the morning decided to change something concerning the schedule we were already in bed…, which meant that we couldn't get the information until much later. This fact has meant some difficulties.*

Critical remarks like this one can partly be explained by the fact that communication with Stanford always had to take place during the evenings (Swedish time) because of the time difference. Changes in schedule meant, for example, that other planned activities during the evenings had to be cancelled.

The official course language was English and this was not perceived by the GU students to present any great problem, as they had the option to choose Swedish literature and were allowed to write and present their work in Swedish. They also appeared to experience the use of English as unproblematic in the communication with SU.

On the questionnaire item on the subject of whether the GU students perceived that communication with SU had worked in a satisfactory way, the majority answered however

that it had not. They did not consider that this was due to either lack of language skills or the time difference between Sweden and the US, but instead to course organization and value for collaborating with their counterparts. Moreover, the technical problems associated with Marratech were the greatest hurdle. For example, the sound quality was often poor when the program was used in conjunction with the webcam, which was therefore not frequently used. There were also problems with the Whiteboard and no one knew why. The students believed that the technical part of the course would have worked much better, had it only been thoroughly explained at the start of the course and clear instructions provided.

In general, both sets of students found that the on-line communication and collaboration had not added enough value to their coursework and they were disappointed about that since that was one of the unique components in the course that compelled many students to take it. This is, according to the faculty, the most important thing to change and develop before the start of the next joint course.

Technological difficulties, mismatches of time-of-day between Gothenburg and Stanford, differences in student educational experiences and focuses, as well as the overall difficulty of creating and integrating meaningful cross-cultural exchanges with regard to conceptually complex course content, were all likely contributors to the frustration the students felt at certain times during the course. However, students had a multitude of suggestions for improving these interactions. These suggestions typically fell into the categories of improving technological ease-of-use, improving consistency and relevance of weekly interactions, and framing interactions such that students had increased need/desire to interact. In general, there was among the students an overwhelmingly positive attitude toward the pedagogical approach that emphasized constructable and researchable skills through collaborative research.

C. The cross-cultural collaboration.

Perhaps the biggest challenge of implementation was the facilitation of communication between Swedish and American students. The course design was such that students, as previously mentioned, interacted mainly via Marratech with students working on similar storyboards, but projects were not shared. The aim was that students would be able to discuss each other's projects, and provide insight. Unfortunately, this free exchange of ideas did not proceed as hoped for. There are several possible explanations for the poor communication. Early technology problems as well as groups being mismatched, meant that students were not able to communicate with other groups as planned. Language barriers were a minor problem, but it sometimes made the students frustrated particularly with scientific terminology.

In future collaborative courses, it may be valuable to require each cross-cultural group to work on a shared project with a common grading scheme at each university, so that the students have a common interest and motivation to communicate and successfully complete the projects. As implemented, there were no negative consequences (aside from lack of additional perspective) if the cross-cultural interaction did not proceed successfully. This would also require a similar cooperation in evaluation between the faculties at both institutions.

According to Bohlin and Kocken (2007) it was problems with the ICT that were the main reason why this cross-cultural aspect of the course did not work as the course leaders had hoped. They concluded that organizational measures need to be taken in future courses in order to get a positive development of the cultural aspect of the project.

The faculty claimed that the cultural differences between Gothenburg University in Sweden and Stanford University in the USA resulted in some problems concerning the

collaboration. These variations had to do with slightly diverse views on some pedagogical questions and differences in technical resources as well as staff. SU had more staff assigned to the course as well as better technical resources and support. This meant, on the other hand, great challenges and a striving among faculty for success despite the differences.

Faculty also called attention to the fact that through the RUN course students already at bachelor level had the possibility to take part in a joint international course between universities, cross time-zones, meet and listen to international experts in the field and develop possibilities for international relations and project-work. This was indeed something faculty had to emphasize even further, in order for the students to notice and make use of it.
Faculty also pointed to the fact that the students learned communication skills and how to cooperate with colleagues with the same education in other parts of the world and that these generic skills also had to be regarded as important learning outcomes. The Swedish students were used to cooperating in groups and didn't see this ingredient of the course as very different from other courses they had been taking, while the American students were more challenged by teamwork in the course.

The Swedish students were older than their American counterparts. Some had already families, a part-time job and a very active life-style beside their university studies. The American students, on the other hand, had a different main subject and could choose the RUN course as a course among others in order to get a certain profile in their study-program, while the Swedish students had it as a mandatory course in their sport-science program. These cultural differences did also result in different expectations and a different approach towards the course.

In their evaluation of the course students suggested that to make the global component of the course work (working with team members from the other university) would be to 1) remove the technological challenges; 2) design a project that is truly collaborative where a team of GU/SU students have a single project and contribute to different aspects of the project – otherwise there was no incentive to collaborate.

VII. Discussion.

Clearly there is growing professional agreement that new and more student-centered teaching needs to be developed and acknowledged in higher education. Instead, traditional teaching methods have focused on lectures that have served the interests of teachers more than they have served the interests of students. What contribution new technology can make to the improvement of the standard of higher education and to student learning also needs to be explored. In this paper, we have presented a project that tries to improve the quality of teaching and learning through the use of new technology, cross-cultural collaboration, new pedagogy where problem based learning is central, and where students can start their journey on becoming able to conduct research; i.e. to become research-able.

Our increasing awareness of the limitations of traditional methods convinced us that we needed to develop and explore alternative strategies of teaching and learning. Such strategies should include active participation from students concerning their own learning, new technology, distribution forms and problem based learning where students need to search, evaluate and adapt knowledge and skills in real world settings. We also decided to include an international aspect to the course, where students had to interact with students at another university in another cultural context. This would, we argued, mean that the students also received "cultural knowledge" and that they could compare their own knowledge with students studying in the same content area in another country. We thought this would add another dimension to their professional development. The challenge as an educational

research project was to be able to successfully implement such a complex course with only one iteration of the course design.

It is of course not possible to state that one teaching method is better than another, because it depends on so many variables and the context in which it is used. However, almost all students were positive toward the course design and the PBL method that was presented. This was probably due to increased motivation and as a result of being challenged and involved in their own learning while searching for information via their storyboards. According to Bohlin and Kocken (2007), a contributory factor to their positive attitude toward PBL was that collaboration within the group had been satisfactory; both the method of working and the design of the course were perceived as stimulating. What was missing from the GU students was sufficient basic knowledge of biomechanics and many students expressed frustration at having to acquire knowledge themselves in this area.

From the start, students at both GU and SU were eager to connect with their counterparts using web-based ICT programs. The students hoped to exchange knowledge; i.e. learn from colleagues on the other side of the Atlantic as well as make new friends. The new contacts would also make it possible for them to assess their own level of knowledge within the field in comparison to their counterparts. Since this was a pilot, a few major limitations prevented successful and sustained interactions between the cross-Atlantic teams: technical, pedagogical, and organizational. The main limitation was to have a similar technological set-up on both sides with standardized equipment and rooms set-up and available for students to communicate in. Had there been no technical problems and had the organization allowed more interaction, the picture would most likely be different.

Since this type of exchange was also new to many students, more guidance and structure from the course directors were requested by the students to foster the interactions, help define common goals for the interactions, and "break the ice". Students on both sides were eager to have the global exchange and expressed disappointment with the technical failures. As mentioned in the results section, while students were able to be friendly with their counterparts, the buy-in on the academic work was more challenging since both sides had their own project and had little knowledge on how to use each side's strengths. As a result, most groups worked independently.

The cross-cultural collaboration was less than the researchers hoped for, because it lacked the desired results. The reason for this was primarily that the groups did not know how to make use of the other group, which was why many of them decided to work independently. Another reason was lack of communication at leadership level between GU and SU, which resulted in a smaller number of mixed groups than intended. A third reason was that the storyboards were different – two being applied and the four others a bit more traditional – which meant that the work in the groups varied a bit too much. A fourth reason was technical problems, which obstructed a transparent exchange of knowledge. Had there been no technical problems and had the organization allowed more interaction, the picture would most likely be different. Many students described it as regrettable that this part of the project did not work as intended and that the commitment on the American side did not seem to be one hundred percent in terms of the cultural, comparative aspects. The specified shortcomings need to be improved in order to get the students even more involved and to foster cooperation between students as well as members of faculty. In a wider perspective, this course was a singularity and a first time experience for most students and teachers. The natural human inertia towards changes and the technical and administrative shortcomings may explain the somewhat meager outcome. This type of course might include projects that are truly collaborative if this learning strategy is more widely used and familiar, if ICT-infrastructure and course management is working and most important, faculty are truly in

favor of it.

VIII. Conclusions.

While student satisfaction with the aims of the course was high and technology facilitated a unique cross-cultural opportunity, the challenges of maintaining reliable technology and matching student expectations proved difficult. The majority of students had a positive attitude toward the idea behind the project and argued that the course would probably turn out successfully after evaluation and discussion about shortcomings. The conclusion is that a vast majority of both the GU and the SU students liked the design and the implementation of the course and were enthusiastic about the student centered approach. However, there is a great deal that would benefit from improvement and that in particular the cultural aspect must be more clearly emphasized.

The overall pedagogy of the course inspired students to learn about the research process as a result of the teamwork and group projects. As with any new pedagogical approach, especially to an interdisciplinary science like sport science, several iterations of a course are needed to refine the planning, organization, technologies, and approaches to learning. To develop the global component of the course requires an adaptation to the learning goals – the cultural aspect must be more clearly emphasized to successfully incorporate the global component of the course.

However, there is little doubt that lectures made accessible through the Internet and the Web will provide an important piece of the puzzle for developing courses not just for campus students but also for "virtual" students who could be resident anywhere in the world (Milliken and Barnes, 2002). We have tried to expand this approach further by giving a joint course at two different universities using mixed groups consisting of students from both Sweden and the USA that are confronted by storyboards consisting of problems that needs to be solved and presented as a joint venture.

The students had to be able to apply their knowledge in a real-world situation related to the subjects presented in the course. From our ethnographic data we know that this task was considered valuable by the students. However, some of the students also asked for a more traditional approach to teaching and learning, with hard facts communicated through traditional lessons. There were also students who experienced difficulties in taking a greater responsibility for their own learning, as well as in making personal reflections on their own learning. Reflective writing is not something you easily learn from one day to another, but instead something that takes time and demands effort. Changing established teaching and learning experiences is a slow and long-term project. However, despite many critical comments, the overwhelming outcome was that the students wanted the course to be made permanent.

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